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Easy electronic software for digital logic design

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Abstract

E-learning within a highly interactive environment is essentially applicable for web development nowadays. E-learning today gives students a central role in their own learning process. It allows students to try things out, participate in courses, tests and simulations like never before, and to get more out of learning than before. Technologies that allow interactivity, simulation, and self-testing can help students acquire the skills being taught effectively and efficiently. In traditional lecture methods, students just listen to the lecturers in a passive way, unlike in active learning whereby students are more achieve that in the learning process. This paper describes new software called Easy Electronic Software (EES) has been developed to allow simpler solutions for students taking the Digital Logic Design (DLD) subject especially on basic electronic components. The software provides a calculation method for estimating the value of DLD subject components, which are resistance and inductance. In addition, the software also provides a conversion unit for capacitance. The proposed environment is designed by integrating Adobe Flash and Hypertext Markup Language (HTML) with a user friendly interface and interactive information. This software also presents the Analysis, Design, Development, Implementation and Evaluation, also known as the ADDIE model methodology in order to develop the system. Using this software, students can use the system at their own learning pace. EES is also designed to create an interactive animation learning environment where students could understand and find it easy to memorize DLD subject components by referring to the software. This software also captures the attention of the viewer easily and stays in the memory for a longer period of time. The software will be a medium of transfer knowledge for Information Technology (IT) students and will widen their knowledge in electronic components. The contributions of this paper are towards supporting the e-learning environment for digital logic design learning and an evaluation of its use in this context.

Keywords: Analysis; design; development; hypertext markup language (HTML); information technology (IT); implementation and evaluation (ADDIE)

1. Introduction

The e-learning system is an approach to facilitate and enhance learning based on both computer and communications technology. E-learning today allows students to try things out, participate in courses, tests and simulations like never before, and to get more out of learning than before due to the growth within Internet-based technologies as well as human competencies in the use of these technologies (Ahmed et al., 2010).

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Of teaching only depend on tutors teaching students in class rooms by using the whiteboard which had been used for centuries in teaching around the world. Shifting from these traditional ways of teaching to the modern approach of the e-learning system is challenging and also interesting.The popularity of electronic learning programmes force us to think about what advancement in technologies can enhance of learning. According to Hodhodet.al (2010), open source software and communications have also made it possible for a wide range of people to own a computer system at reasonable price and get high speed internet access.

The demand for tools, interactive experiences and open access to knowledge is growing (Shaffer & Small, 2004). Learning is no longer expected to be paced so much by the lecturer as it is by the student's capacity to grasp the material. The speed at which students can progress through a course of instruction varies by factors of three to seven, even in classes of carefully selected students (Gettinger, 1984). In traditional training models, it is impossible to deliver individually customized learning solutions because of the cost. The capacity of e-learning for real-time, on-demand adaptation can provide individualized learning at affordable cost. Additionally, the educational topic selection can cater to a student's particular needs. Any given student may be studying any given topic at any time, and progressing through that material at a pace appropriate to his or her learning ability.

For Information Technology (IT) students, Digital Logic Designs (DLD)(Morris & Charles et. al, 1997) is one of the core subject. DLD contains topics that cover the basic electronic circuit, combinational or sequential logic circuits and also how the memory characteristics work. The concept of digital logic has important use in all of today's digital computers and devices. It has had such a prominent role in everyday life in the recent digital age. Traditionally, students just learn the subject in class and simply depend on textbooks after that. For certain components, students need to memorize and always refer to the values of the code colour. Sometimes the manual system gives inappropriate values because of lack human dedication. It also takes too long to calculate and convert the values. Apart from this, students faced difficulty to identify the exact inductance or resistance components because of tiny strings which represent the code colours. This causes students to set up the circuit wrongly and it also incurs high cost to re-fix it. Somehow this classroom setting does not engage the students to learn more because they have become more technology savvy and they want to get many of their course materials off the Web. In fact, several problems that have been identified are as explained below:

- students find it is hard to remember each colour code given.
- it is the time consuming to calculate and convert the values.
- cost to re-fix the circuit is high.
- theories learned in class will not be able to be understood thoroughly

Students usually found the topic of digital logic design materials boring and complex. The materials are difficult to visualize. The proposed solution is by introducing Easy Electronic Software, web based software that help users to understand the electronic components such as resistance, capacitance and inductance. The software also provides calculation methods for estimating the values of resistance and inductance. In addition, the software also provides a conversion unit for capacitance values from Microfarads (μf), Nanofarads (nF), and Picofarads (pF) and to Microfarads (μF), Nanofarads (nF) and Picofarads (pF). The information about the color code will be installed into the system, so that students do not have to refer to the books for the color code information and can easily convertedthe units. In addition, students will remember the formula by using the software frequently. Thus, is possible to create a conducivelearning environment in which students become active participants, fully engaged in the learning process.Hence, the objectives of the application are:

- to provide calculation methods and conversion unit for students in the easiest and most creative way.
- to enhance learning for students taking DLD as a subject.
- to enable students to get the exact values of the components.
- to save time and reduce cost.

The rest of this paper is organized as follows: literature review will be in section 2, followed by the research developmental framework in section 3. Section 4 will be focused on research methodology and section 5 will explain research implementation. Finally there will be a conclusion in section 6.

2. Research Analysis

A few systems have been analyzed which are the Hamburg Design System (HADES) (2010), Digital Logic Builder (DLB), Mobile Virtual Lab (MVL) and Circuit Building Application (CBA) (2010) to facilitate the growth

within internet-based technologies. For example, the Hamburg Design System which was developed by the Computer Science Department, Hamburg University; Germany is a pure-Java framework for object-oriented component-based simulation. It consists of a graphics editor to create and interact with simulation setups, an intuitive design with library browser and also a library of JavaBeans-compatible simulation models. This application is designed for the digital logic subject and the application uses Java. However the disadvantage of this application is that the user manual is very complex and they do not provide student records, so it is easier for students in the laying out of the experiment they have done.

Then, DLB was originally conceived and developed for the use of Bachelor in Information Technology students as part of the UK National Learning Network programme, being an interactive multimedia simulation that allows students to drag logic gates onto a grid and specify inputs into a circuit. The programme is delivered online through Moodle, an open source Virtual Learning Environment (VLE)(O'Leary &Ramsden, 2002).Nevertheless, this virtual lab was relatively limited in scope.Another example, MVL, uses Java 2 Micro Edition (J2ME) platform(Shaylor et al., 2003) which is designed for the development of applications for small devices of limited capabilities, like mobile phones, smart phones and PDAs. Glavinic et al. (2007) states that MVL represents a complex software unit with many options, modes of behavior and supports the process of teaching and learning of digital design. MVL also performs simple laboratory exercises using mobile phone devices and also brings the user closer to implementing a full-scale mobile virtual laboratory. But then these mobile applications have several weaknesses such as having small display areas, low resolutions, input limitations, limitations in accessing the Internet and also lack of standardization and compatibility.

CBA was designed by final year students from the Engineering Faculty, John Hopkins University, in America. This application can only be accessed on-line. The laboratory experiments are too basic and no informationsnor on-line help button are provided in this application. The major difficulty is that the student cannot take out the component which is in the board when it is not in the right place. The student will encounter confusion on how to use this application.

3. Proposed System

The proposed system,the Easy Electronic Software (EES) used Adobe Flash and HTML in order to develop the interface. EES is designed to create an interactive animation learning environment where students could understand and easily memorize DLD subject components by referring to the software. Besides, students can save their time by calculating the colour code value automatically using this software. They only need to click on colours to get the information or the value of the variable colours. In addition, they just need to input the capacitor value to convert to another value. It is easier for them to identify the exact component. Besides, the system is developed with a user friendly interface and interactive information. In fact, this software captures the attention of the viewer easily and stays in the memory for a longer period of time.

From the analysis of the several systems above it is shown that EES expands on an online basis and this software provides calculation methods for resistance and inductance components. For the capacitance component, conversion unit values are prepared for the user. The mouse over information about the electronic components using Adobe Flash is also provided in the system. An interactive and user friendly interface is also considered.

4. Framework Design

4.1. Digital Logic Design

Digital Logic Design consists of two parts, scope and structure. Hence, the subject is divided into two sections, which are basic and advanced, as below:

- Basic chapter - Fundamentals of Electricity, Electronic Application, Ohm's Law, AlternatingCurrent and Semiconductors.
- Advanced chapter - Binary Number Systems, Basic Logic Gates, Simplifying Logic Circuits, Sequential Logic Circuits and Combinational Logic Circuits.

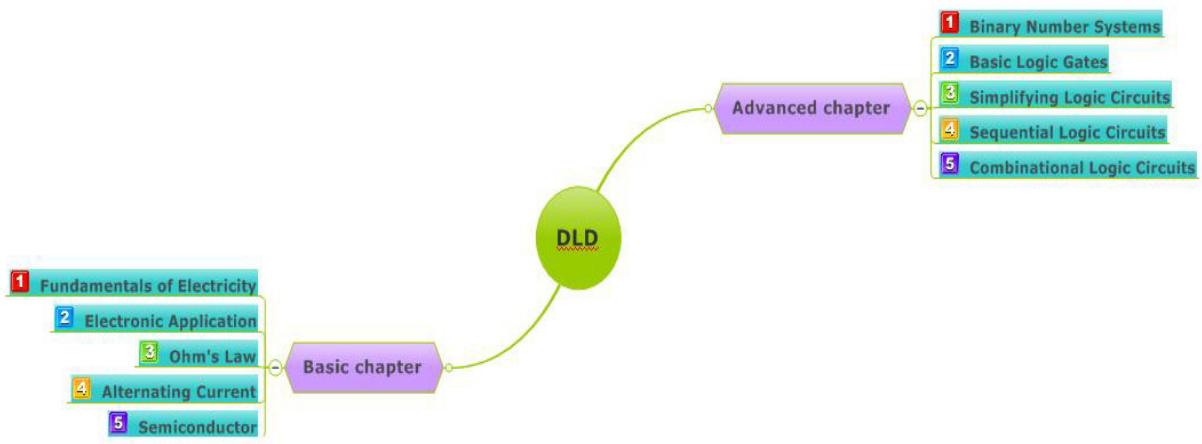
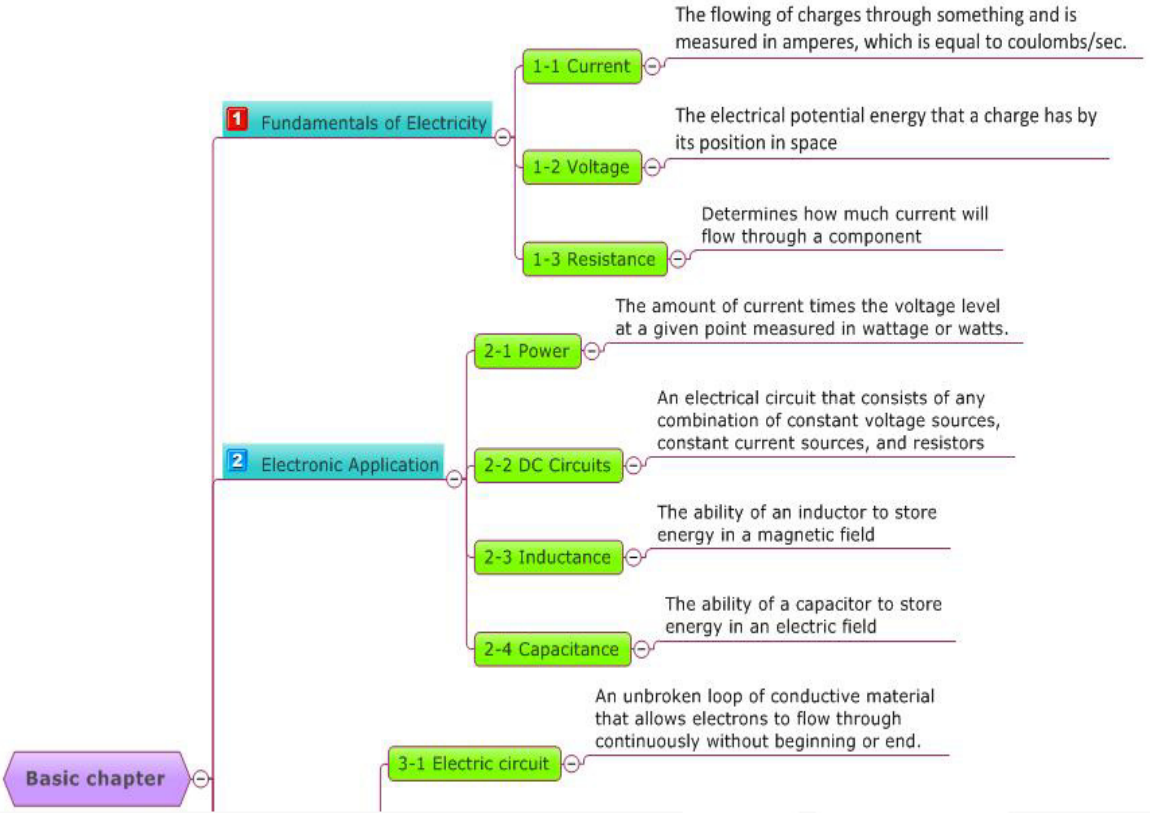


Figure1.DLD scope

For the basic chapter, there are five main chapters that have been identified. Each main chapter has been divided into several sub-chapters as shown in Figure 2.



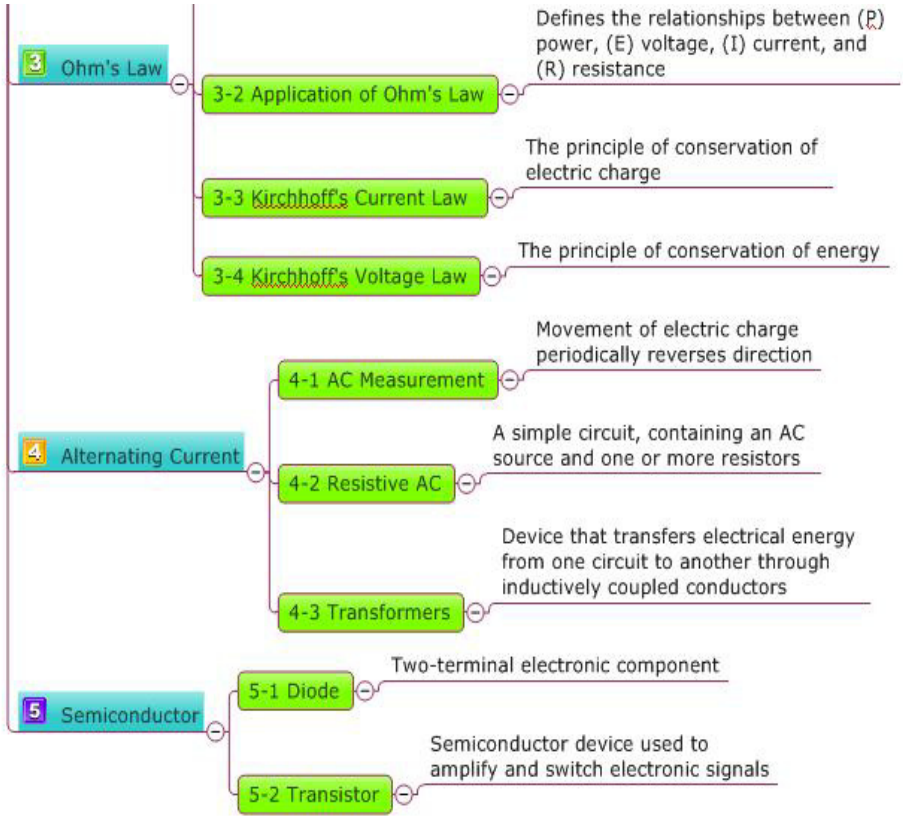


Figure 2.Basic chapters

For the advanced section, there are five main chapters that have been identified. Each main chapter has been divided into several sub-chapters as shown in Figure 3 below.

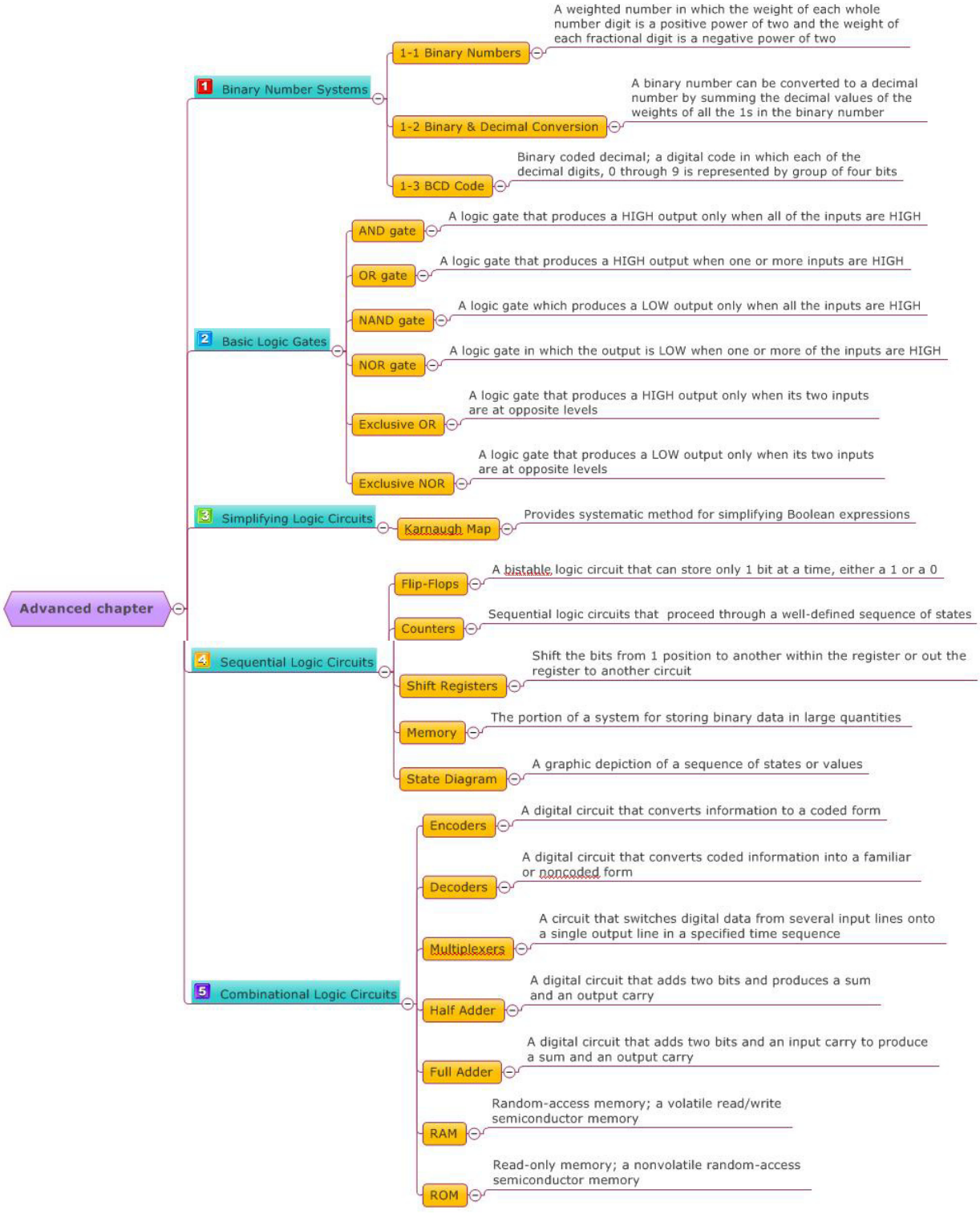


Figure 3.Advanced Chapters

4.2. Easy Electronic

Easy Electronic Software has two parts, which are design and scope. The details will be explained below.

EES has five menus which are home, components, resistance, capacitance and inductance as shown in Figure 4. The particulars of each menu are explained in Table 1.

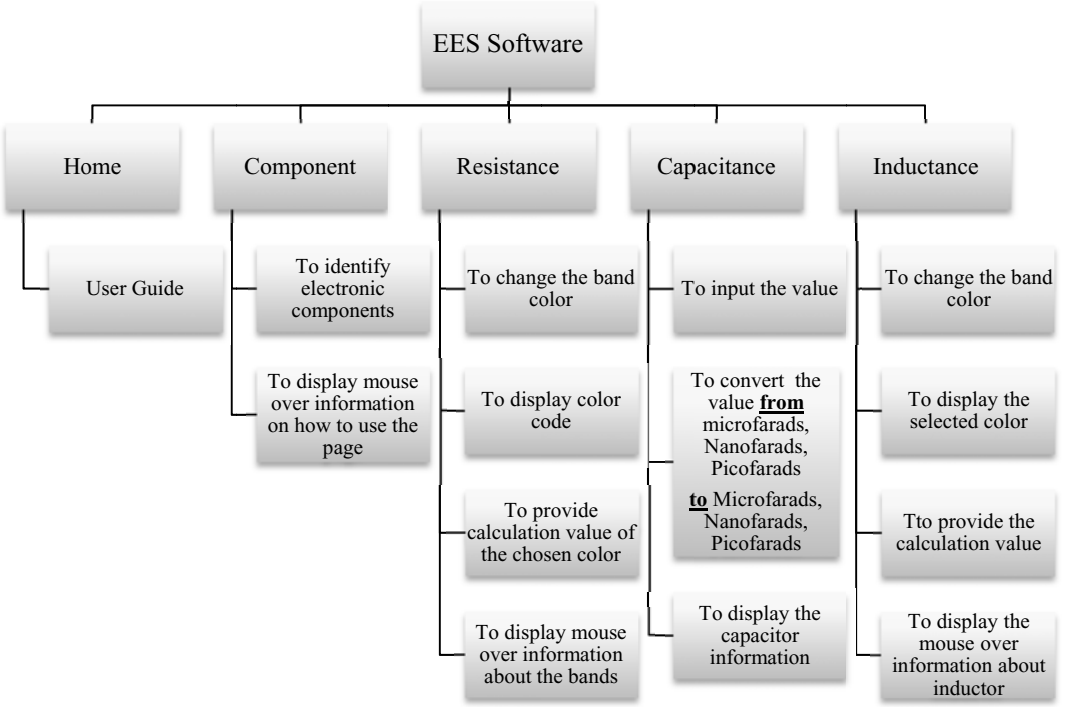


Figure 4.EES Design

Table 1. EES Menu Details

EES Main Menus	Page Descriptions
Home	• This is a user guide and introduction page for novice user. There are 4 other menus, which are components, resistance, capacitance and inductance.
Components	• This page displays informations about electronic components including resistor, capacitor, inductor, switches and batteries. • This page also provides informations for user on how to use the page. • Users can select their desired components by clicking the combo box and the screen will display the selected components.
Resistance	• This page provides two types of band color which are 3 bands and 4 bands for users to choose from. • This page displays thecolor code and users can click the colorin order to get the resistor value. • This page also provides informations for users about the band colors.

Capacitance	• The user is requested to key-in the value from Microfarads, Nanofarads and Picofarads or to Microfarads, Nanofarads and Picofarads • The system will convert the unit of capacitor value to another unit as above. • This page also provides the details of capacitor information.
Inductance	• This page only shows one type of band which is 4 bands. • This page will display the color code and users can click on the colorin order to get the inductor value. • This page also provides information for users about the inductor.

The EES scope is divided into three including resistance color code, inductance color code and capacitance unit converter as shown in Figure 5.

Figure 5.EES Scope

5. Methodology

Utilizing computers as a learning resource requires well-studied techniques and methods to achieve successful knowledge transference. This software adopts a proven effective methodology that combines the latest instructional design theories with advanced multimedia technology tools. This paper utilizes the ADDIE (Analysis Design Development Implementation and Evaluation)model as the methodology for developing the software.

The ADDIE instructional design model aims at a student-centered rather than the traditional teacher-centered approach of instruction, so that effective lifelong learning can take place. This means that every component of the instruction is governed by the learning outcomes that have been determined after a thorough analysis of the researcher's need. The ADDIE model is an interactive instructional design process, where the results of the formative evaluation of each phase may lead the researcher back to any previous phase. The end of one phase is the starting of the next phase (Gustafson and Branch, 2002).

The ADDIE model of instructional design is a basic model that can be applied to any kind of learning solution. ADDIE is also a simplified abstract view of a complex reality or concept. The ADDIE model is used to develop the application because of its emphasis on analysis and provides detailed job aids for each of the five major steps.

First step is the analysis to determine the users, why this system was developed, the problem, the objective, the scope and so on in order to get the full picture about the system. The next steps is the continuation with the framework design and structure of the software. It comprises as many chapters as needed to be considered while analysing this DLD. The design and structure need to be clearly determined in order to produce excellent results. The third step is when Adobe Flash and HTML were used to integrate and design the interactive interface for the development. Adobe Flash is preferred because it's engagement with the learning process. Fourthly, Action Script of Adobe Flash and HTML programming language are chosen to implement this system.

Finally, the software will be tested and evaluated by several users. The evaluation method includes questionnaire, interview and also observation results which are used to assess the overall effectiveness in order to seek accurate decisions, efficiency and to achieve the objectives of these software. Fig 6 defines the process of method used.

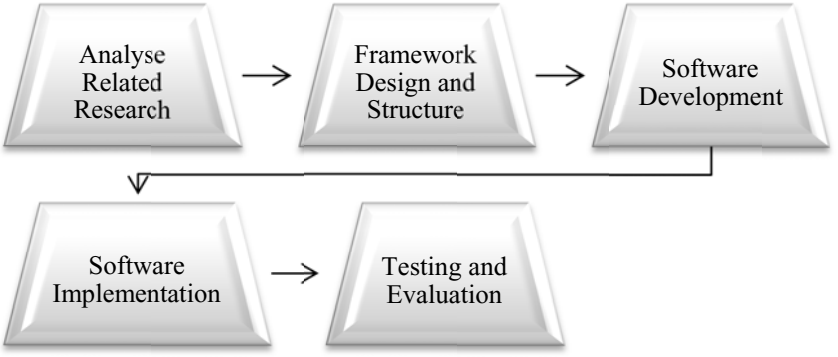


Figure6.The ADDIE Model

6. Implementation

Implementation of the EES software is designed with Adobe Flash and HTML as the tool, with its animation and attractive graphic display. This software presented a simpler solution for electronic components including resistance, inductance and capacitance with the convenience of learning at their own pace. For resistance and inductance, the system will provides the calculation value according to the type of bands. There are two types of band for resistance which are 3 and 4 bands, while there are only 4 bands prepared for inductance. Meanwhile the system is also designed to help the user to convert the unit of a capacitor value to another unit. There is also interactive information on each component. Fig 7 shows the interface of the resistance color code.

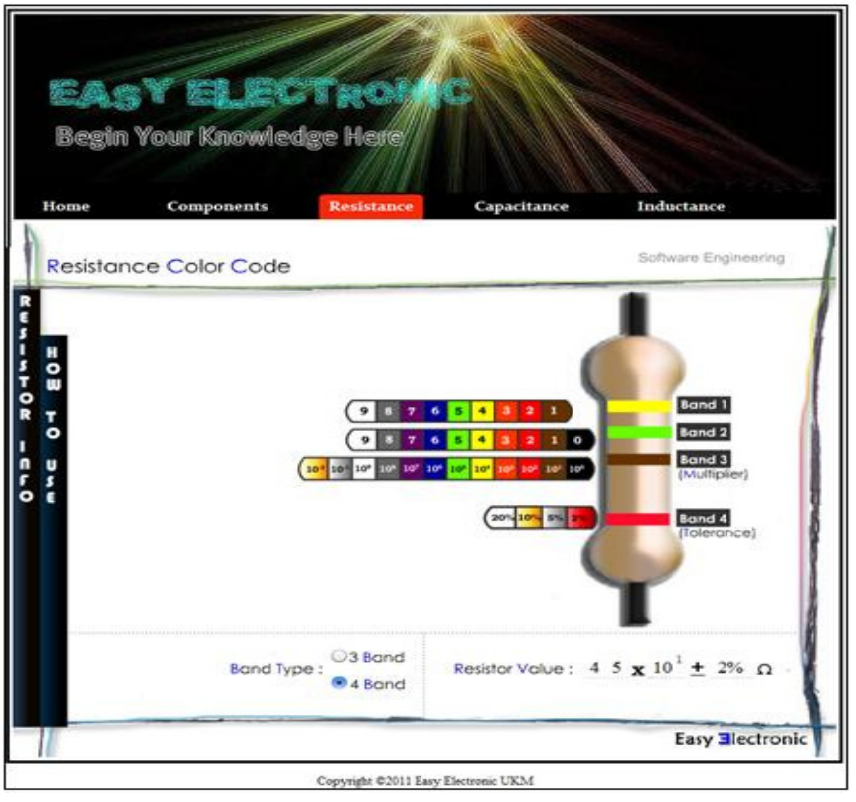


Figure 7.Resistance Interface

7. Conclusion

Easy Electronic Software is presented to enhance Digital Logic Design subject learning for IT students. The software will provide the calculation method for electronic components such as resistance and inductance. In addition, the software also provides a conversion unit for capacitance. The proposed framework design consists of two DLD chapters, which are basic and advanced. The software is simple and easy to be implemented using simple tools to support e-learning systems for digital logic design. The software creates a better way for students to engage with the system. EES implementation will expose them to the process of thinking creatively and effectively at their own learning pace. Using this software, students can widen their knowledge in electronic components with neither mastery in code calculation nor the conversion aspect. There is a plan to enhance the software by adding more features, by adding video, numerous graphics, virtual elements and various sound clips for future.

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